APPENDIX D

MODELING REPORT

AIR QUALITY MODELING REPORT
HOKU SCIENTIFIC, POCATELLO

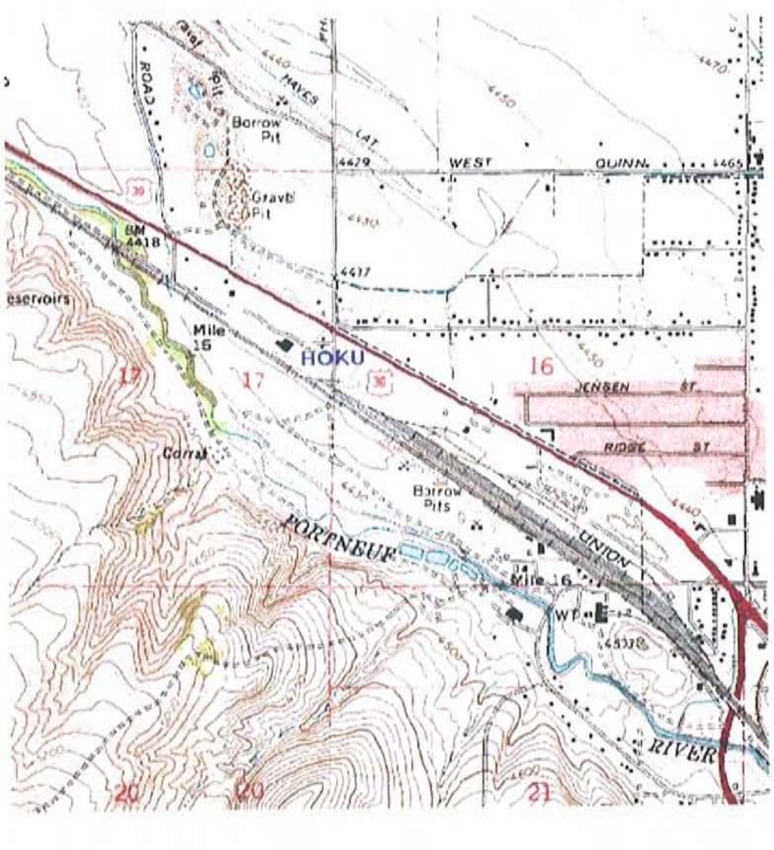
PURPOSE

This air quality modeling report describes modeling prepared to support proposed modifications to the permit issued in 2007. The templates for this protocol are the modeling report IDEQ approved for the 2007 modeling analyses, and the March 2008 modeling protocol approved by IDEQ (a copy of which is included in Appendix C). The only deviation from the approved modeling protocol is an adjustment of the location of buildings and sources on the facility to make sure they are consistent with current design and construction plans. Kevin Schilling provided written acknowledgement, copied in Appendix C, that the approved protocol would remain valid with those changes. This document describes the air quality analyses prepared to support the Permit to Construct (PTC) modification for the planned Hoku Scientific polysilicon plant off Highway 30 in northwest Pocatello.

INTRODUCTION

This modeling analysis was prepared to support the facility's application for a permit modification, which includes a Facility Emission Cap (FEC) consistent with IDAPA 58.01.01 air quality regulations. The facility will remain a Title V minor source. The modeling was prepared consistent within IDEQ approved modeling protocol. Figure 1 below shows the facility location.

Figure 1 Hoku Scientific Facility Location



MODEL DESCRIPTION / JUSTIFICATION

The model chosen is AERMOD, the US EPA approved model recommended by IDEQ. AERMOD has recently replaced the Industrial Source Complex model ISCST3 as the primary recommended model for facilities with multiple emission sources. AERMOD was applied as recommended in EPA's *Guideline on Air Quality Models*, consistent with guidance in IDEQ's *Air Quality Modeling Guideline*. Recommended regulatory default options were employed. Terrain data was processed consistent with the IDEQ guidance, discussions with IDEQ's Mr. Schilling, and EPA guidance for AERMAP, as documented in the IDEQ-approved modeling protocol. Meteorological data recommended for this application was supplied by IDEQ. The Prime building downwash algorithm was employed. Modeling analyses were performed for all pollutants emitted above IDEQ emission thresholds. That included PM-10, and NO_2, CO and SO_2, and toxic air pollutants (TAPs) exceeding the IDAPA 58.01.01.585 or 586 emission levels (ELs). The TAP impact analyses conservatively include all facility emissions for each TAP, though IDEQ requires impact analyses from only increases in TAP emissions from those currently permitted. Chemical transformation of emissions was not considered. All these details were included in the modeling protocol which IDEQ approved. The only condition of IDEQ's acceptance is addressed in this analysis.

EMISSION AND SOURCE DATA

Model stack and emissions data representative of the worst case emissions at the Hoku Scientific facility were incorporated directly into the air quality modeling analysis. This generally represented slightly higher capacity equipment and process design than originally permitted, with stronger exhaust flows and increased emission rates. All model stack parameters except the emission rates were provided by the engineers designing the facility and construction plans. The project engineers report that in all cases, the stack gas temperatures and flow rates were determined using "standard of care" engineering analysis. These parameters were determined from the process needs (combustion, ventilation, pressure) with guidance from equipment suppliers and or licensors. Emission rates modeled for each pollutant are the maximum emissions under proposed operations over the duration of the standard for that pollutant. That results in different emission rates for the same pollutant for annual and shorter term averaging period analyses. The derivation of all emission rates is documented in the permit application this modeling report accompanies.

The emission inventory was developed consistent with worst-case conditions anticipated during operation at the facility consistent with current facility plans. The facility emissions were conservatively estimated to exceed IDEQ modeling thresholds for criteria pollutants PM-10, NOx, SO_2, and CO, IDAPA 58.01.01.585 TAP HCL, and six IDAPA 58.01.01.586 TAPs. The modifications proposed from currently permitted activities are limited to changes in emission rates, stack diameters, and stack exit velocities, and a realignment of processes and development across the Hoku facility property. No new sources are included as compared to the original permit, but changes in location are proposed for previously permitted emission point or area source.

Table 1 summarizes the pollutant emission data consistent with the proposed modification. The changes from draft model source data presented in the IDEQ-approved modeling protocol are limited to differences identified in Q/A against the final permit emission inventory.

Modeling analyses were performed for all pollutants listed in Table 1 to estimate maximum impacts during each averaging period for which an applicable ambient air quality impact limit exists. All model sources had emissions understood to represent worst-case permitted emissions for each averaging period to estimate the worst case impacts under allowable emissions from the facility. The Hoku stack parameters represent planned actual emissions scenarios. Potential worst-case impacts for each pollutant and averaging period were directly output by the model. All model source data underwent quality assurance review by JBR Environmental, the engineers designing the facility, and the facility owners and representatives.

The facility submits this application in accordance with facility-wide emissions cap (FEC) sections of IDAPA 58.01.01.175 – 181. Consistent with FEC requirements, this analysis may be updated as necessary during the term of the FEC permit to ensure that the analysis estimates worst-case impacts during actual and potential operations within the permit.

Building downwash was accounted for by including in the AERMOD model analysis Prime building downwash from all buildings within the facility. All Hoku buildings and tanks over 10' tall are included in the building downwash analysis included in the modeling. Appendix A provides a summary of the building downwash run analysis and results from the BPIP-Prime input and output files.

One external potential co-contributing source recommended by IDEQ, Great Western Malting, was included in the modeling analysis using data provided by IDEQ. The buildings at Great Western Malt were also included in the BPIP building downwash calculations for this analysis. Great Western model sources are those in Table 1 that do not include a source description. The impact of the Hoku facility in combination with the IDEQ-recommended co-contributing source is provided with the analysis results reported later in this document.

Figure 2 shows the model layout, with the facility property / ambient air boundary. Facility buildings and tanks are shown in black within the facility boundary, and facility emission sources are shown and labeled in red. The blocks and overwritten red labels to the bottom right of the Hoku property boundary represent the buildings and emission points for the Great Western Malt sources included in the modeling analysis. The background grid is the UTM coordinate system, NAD 27, whose units are in meters. The dots beyond the property boundary indicate the inner-most model receptors. Finer details of this figure are included in the electric data file submission and in Appendix B, with the views broken up for the E and W side to allow a zoomed view of detail.

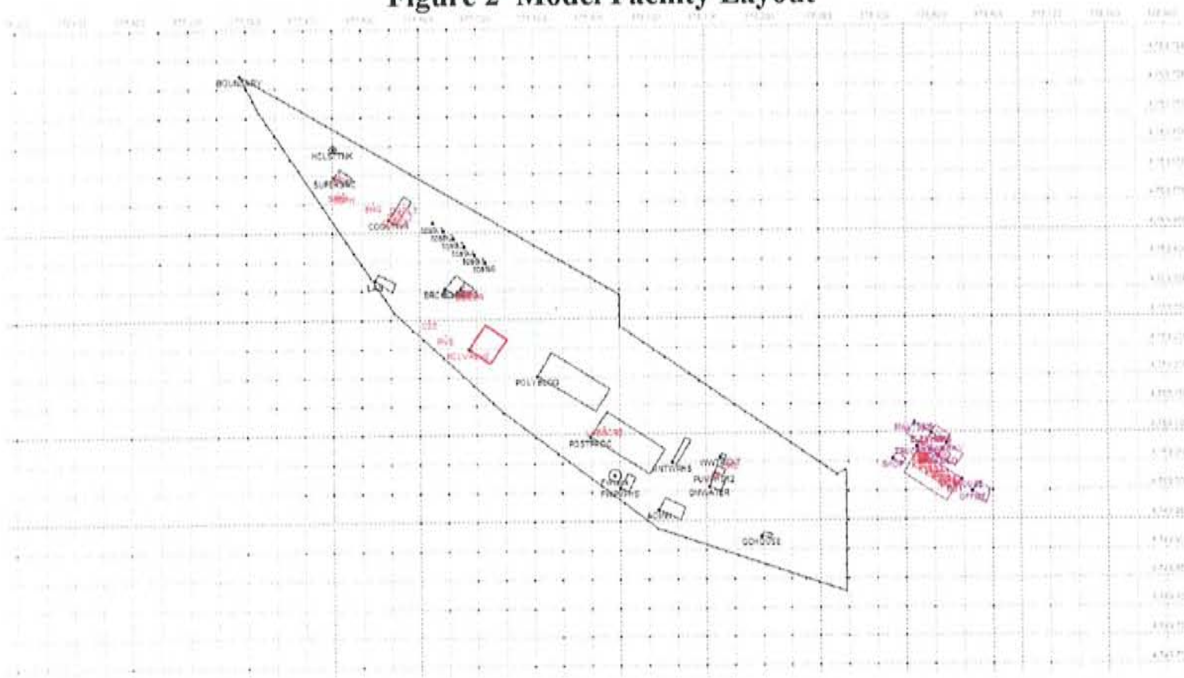
Table 1 Model Source Data

POINT SOURCES			Easting (X)	Northing (Y)	Base Elev	Stack Height	Temp	Exit Velocity	Stack Diam	PMTEN	PMTEN AN	NOX	SO2	SO2AN	CO	HCL	NG TAPS	BENZENE	FORMALD	BENZAPYR	PAHS	CADMIUM
Source ID	Stk Rel Typ	Source Description	m	m	m	ft	°F	fps	ft	lb/hr	tpy	tpy	lb/hr	tpy	lb/hr	lb/hr	tpy	tpy	tpy	tpy	tpy	tpy
BH1	DEF		378487.0	4750062.0	1353.0	24.0	60.0	0.003	0.00	0.0663	0.290											
BH2	DEF		378516.2	4750070.0	1353.0	113.0	60.0	0.003	0.00	0.1357	0.594											
BH3	DEF		378485.4	4750090.5	1353.0	113.0	60.0	0.003	0.00	0.0841	0.368											
KSE01	DEF		378483.0	4750053.0	1353.0	104.0	65.0	6.201	20.64	0.1698	0.744											
KSE02	DEF		378493.4	4750046.0	1353.0	104.0	65.0	6.201	20.64	0.1698	0.744											
KSE03	DEF		378504.2	4750039.0	1353.0	104.0	65.0	6.201	20.64	0.1698	0.744											
KSE04	DEF		378516.1	4750031.0	1353.0	104.0	65.0	6.201	20.64	0.1698	0.744											
KSE05	DEF		378526.4	4750023.5	1353.0	104.0	65.0	6.201	20.64	0.1698	0.744											
CS	DEF		378478.8	4750064.0	1353.0	96.5	100.0	0.003	2.33	0.3302	1.446											
BS1	DEF		378535.0	4750011.0	1353.0	112.0	350.0	17.454	2.92	0.3802	1.665											
BS2	DEF		378472.5	4750067.0	1353.0	34.0	400.0	0.003	0.00	0.0190	0.083											
BOILER	DEF	Plant Boiler	377688.0	4750349.0	1353.6	20.0	400.0	47.157	3.00	0.4000	1.740	22.942	0.031	0.140	4.400		0.5	3.50E-04	0.0125	2.00E-07	1.90E-06	2.50E-04
HOH	DEF	Hot Oil Heater	377679.0	4750356.0	1353.3	20.0	400.0	47.157	3.00	0.4000	1.740	22.942	0.031	0.140	4.400		0.5	4.80E-04	0.017	2.80E-07	2.60E-06	2.50E-04
EMG	DEF	Emergency Generator	377521.0	4750503.0	1352.4	26.0	800.0	111.408	2.00	3.2800	0.820	28.140	8.970	4.740	25.800			0.00232	2.36E-04	7.67E-07	1.34E-05	
FP	DEF	Fire Pump	378118.0	4750038.0	1353.0	20.0	800.0	95.493	1.00	1.7600	0.440	6.200	1.640	0.410	5.340			3.95E-04	4.02E-05	1.31E-07	2.29E-06	
COOL1	DEF	Cooling Tower cell	377558.5	4750476.0	1354.1	30.0	84.0	17.323	35.00	0.4900	2.144											
COOL2	DEF	Cooling Tower cell	377566.0	4750487.5	1354.5	30.0	84.0	17.323	35.00	0.4900	2.144											
COOL3	DEF	Cooling Tower cell	377574.0	4750500.0	1354.3	30.0	84.0	17.323	35.00	0.4900	2.144											
SBV	DEF	M.G. Silicon Bin Vent	377463.0	4750554.0	1350.7	24.0	68.0	67.906	0.50	0.1400	0.600											
SPFH	DEF	M.G. Silicon Primary Feed Hopper	377460.0	4750520.8	1349.7	65.0	68.0	147.029	0.17	0.0300	0.150											
SSFH	DEF	M.G. Silicon Secondary Feed Hopper	377470.0	4750519.0	1350.0	60.0	68.0	110.272	0.17	0.0300	0.110											
LIME	DEF	Lime Storage System	378143.0	4750055.0	1353.0	20.0	68.0	25.465	1.00	0.2100	0.900											
LABSCRB	DEF	Lab Scrubber	377923.0	4750113.0	1352.6	20.0	68.0	55.174	1.00	0.1600	0.700	4.200	0.160	0.700		0.007						
CSS	DEF	Chlorosilane Scrubber System	377618.0	4750300.0	1352.0	27.0	68.0	49.615	1.17	1.8300	8.010					0.37						
RVS	DEF	Relief Vent Scrubber	377646.0	4750273.0	1352.1	27.0	68.0	49.615	1.17	0.7300	3.200					0.18						

AREA SOURCES		Easting (X)	Northing (Y)	Base Elevation	Release Height	Easterly Length	Northerly Length	Angle from North	Vertical Dimension	HCL
Source ID	Source Description	(m)	(m)	(m)	(ft)	(ft)	(ft)		(ft)	(lb/hr)
HCLVALVE	fugitive HCl from valves	377686.0	4750248.0	1350.3	5.0	150.0	170.0	35	8.0	0.78

VOLUME SOURCES		Easting (X)	Northing (Y)	Base Elevation	Release Height	Horizontal Dimension	Vertical Dimension	PMTEN	PMTENAN
Source ID	Source Description	(m)	(m)	(m)	(ft)	(ft)	(ft)	(lb/hr)	(tpy)
TB		378484	4750070	1353	56.50	38.68	52.56	0.417	1.826
RB		378510	4750098	1353	56.50	38.68	52.56	0.267	1.168

Figure 2 Model Facility Layout



RECEPTOR NETWORK / MODEL DOMAIN

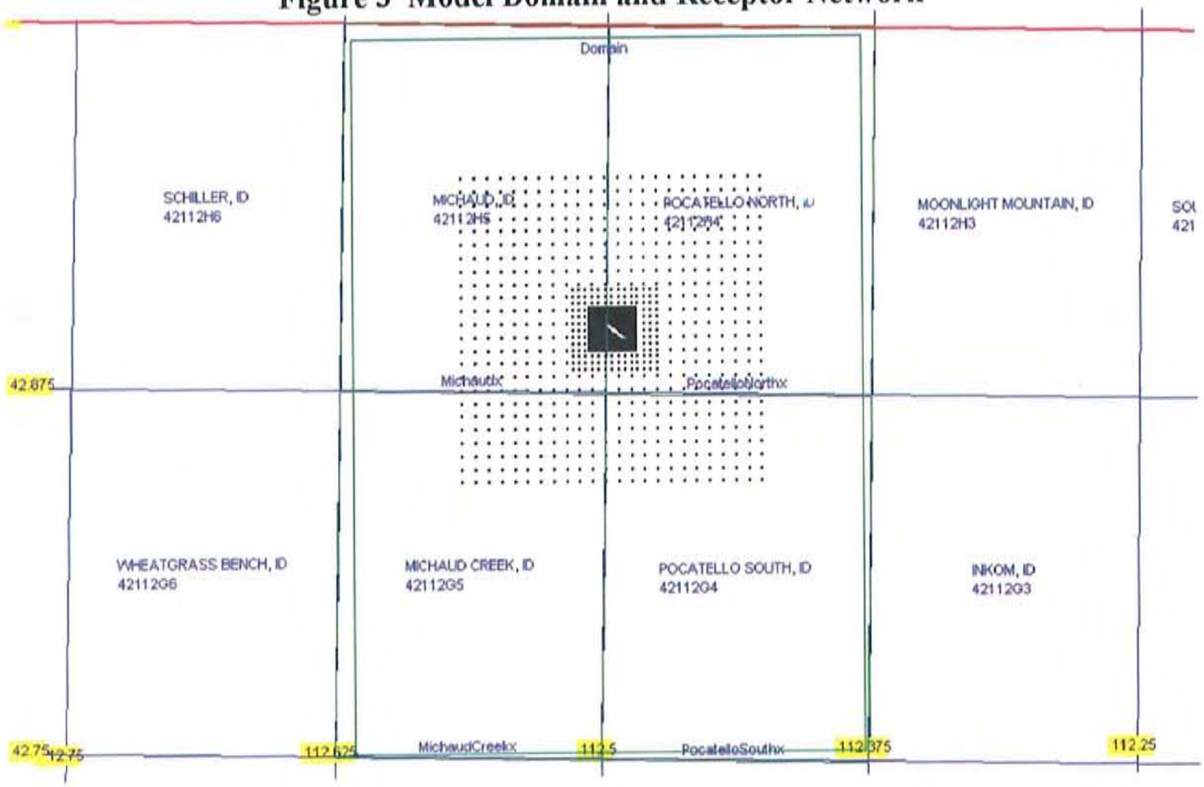
All details described in this section are exactly as described in the IDEQ-approved modeling protocol, and the IDEQ-approved 2007 modeling for the initial permit application. The property boundary / public access limit was used as the ambient air boundary for this analysis. Model receptors were placed from the public access limit out at least 5 kilometers in every direction. The dense inner model receptors can be seen as black dots outside the ambient air boundary in Figure 2. The AERMOD modeling domain was conservatively calculated to include nearly the entire USGS quad for any receptor or any elevated point beyond the edge of the receptor network that meets the AERMAP / AERMOD guidance condition of 10% elevation gain. This method is built into the BeeLine BEEST software used to prepare these analyses, and is recommended as conservative in meeting or exceeding new EPA guidance by software developer Dick Perry of Bee-Line software.

Receptor density is 25 meters along the ambient air boundary, 50 meters for at least the first 100 meters, then 100 meters out to 400 meters away from the property boundary, 250 meters out to 1,000 meters from the ambient air boundary, 500 meters for the next 4 kilometers to 5 kilometers. A few receptors onsite at Great Western Malt were eliminated because that facility had slightly elevated impacts there, where they were not enforceable. Model results for the subgroup Hoku shows that predicted impacts in that vicinity from the proposed action were insignificant.

Figure 3 shows the facility and its ambient air boundary (the white spot in the middle of dense inner receptor network that show up as black in the center), the receptor network (the black dots around the denser inner model receptors), the model domain (green line just inside

USGS quad lines around the receptor network), the latitude and longitude grids in the vicinity, and the USGS quad maps that cover the model domain.

Figure 3 Model Domain and Receptor Network



All model predicted maximum facility impacts occurred at or within 10 meters of the ambient air boundary, within the 25 meter grid density. The maximum impacts are shown to drop off considerably moving toward the outer edge of the receptor network.

The receptor networks employed were consistent with those in the IDEQ approved modeling protocol, and ensured that the analysis meets or exceeds IDEQ receptor network requirements and capture the maximum impact from the facility. Therefore, no supplemental receptor network or expansion of the model domain was required or included.

AERMAP INPUT AND ELEVATION DATA

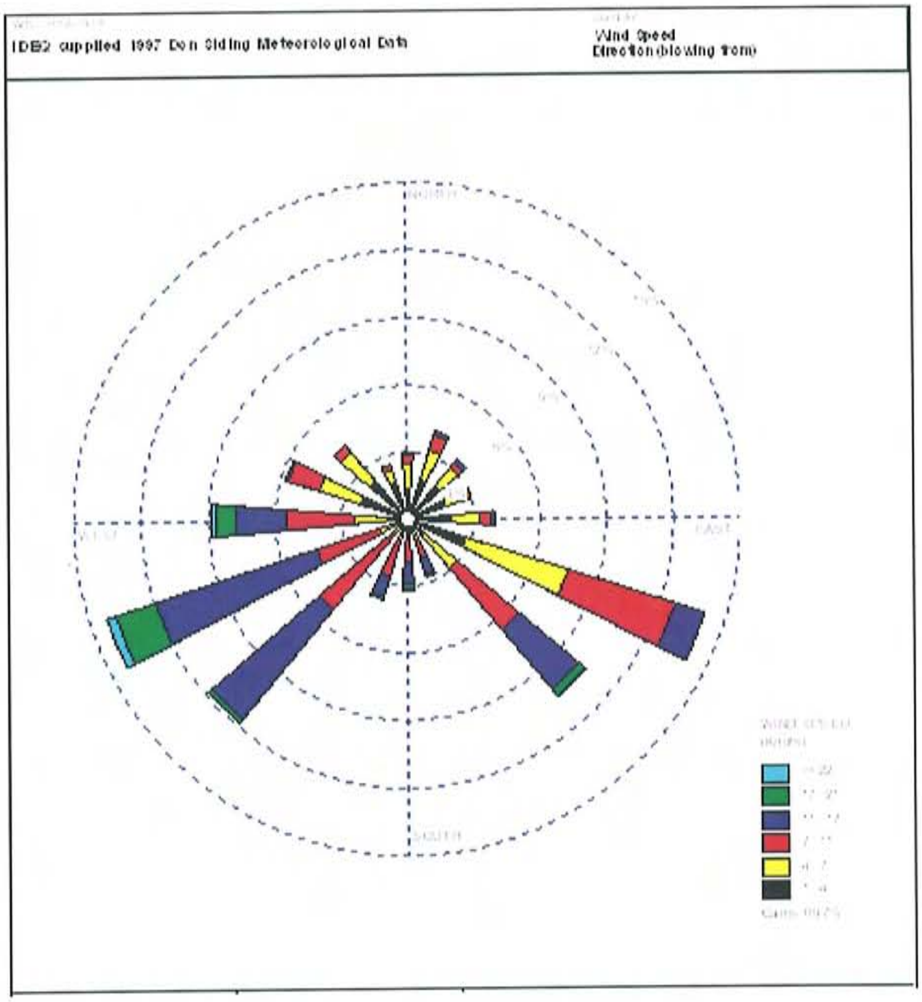
All details in this section are exactly as described in the IDEQ-approved modeling protocol, though AERMAP had to be rerun to accommodate the changes in layout within the facility from previously permitted layout. All building and source base and receptor elevations were calculated from USGS 7.5-degree (30m or less horizontal resolution) DEM data (UTM NAD 27) downloaded from Geo Community (www.geocommunity.com), the USGS freeware download system, using the Bee-Line BEEST preprocessing system. That same DEM data was used in the AERMAP preprocessor to prepare the terrain data for the model domain to run AERMOD. The anchor location and user location required by AERMAP was near the center of the Hoku facility. Electronic data files sufficient to review or duplicate the AERMAP model application are included with this report.

METEOROLOGICAL DATA AND LOCAL PARAMETERS

Model meteorological data recommended for use in this analysis was provided by IDEQ, and applied exactly as described in the IDEQ-approved modeling protocol. The data provided was collected in 1997 at the Simplot Don Siding site #1 location, approximately two miles NW of the Hoku location. The Hoku site is deep enough in the Portneuf Valley to be blocked from the prevailing Snake River Plain WSW winds. The Simplot Don Siding plant is at the mouth of the Portneuf Valley and more exposed to the Snake River Plain winds, though not as exposed to those flows as the Pocatello airport. Though IDEQ approved consideration of wind flow direction alternation to make the Don Siding data more representative, the two convergent flows from the Portneuf Valley and the Snake River Plain made any flow direction alterations challenging to justify. The modeling analyses were performed without any alterations to the Don Siding meteorological data. Default meteorological settings were employed, except that missing hours in the IDEQ-supplied data had to be allowed. Those analyses are understood to be quite conservative, since the modeling meteorological file shows strong winds to the ENE toward the population in the area that are not representative of the actual Hoku location. Hoku reserves the right to consider more representative meteorological data, or an alternative representation of this data, for future modeling analyses. Modeling analyses were prepared for the complete extent of the one year meteorological data file IDEQ provided.

Figure 4 shows the wind rose for the Don Siding meteorological data file used in the modeling. As noted, the strong W and WSW components are questionably representative of the Hoku location within the Portneuf Valley. The use of this meteorological file provides a conservative estimate of impacts to the populated east and northeast of the facility.

Figure 4 Don Siding 1997 Wind Rose



LAND USE CLASSIFICATION

Though the facility is within the Pocatello city limits and there is some industrial land use in the vicinity, by the traditional Auer algorithm or most other reasoning, the land in the vicinity of the facility, across the model domain is generally open and features limited development that will affect wind flow at emission release heights. Therefore, as described in the IDEQ-approved modeling protocol, the urban dispersion algorithm was not employed in this analysis; the rural dispersion algorithms were used.

BACKGROUND CONCENTRATIONS

The background concentrations to be used were recommended by Mr. Schilling of IDEQ. They were applied exactly as described in the IDEQ-approved modeling protocol. The Simplot facility approximately 2-3 miles NW of the Hoku facility is a potentially significant source of criteria pollutants. Mr. Schilling recommended using a high PM-10 background of 94.6 ug/m^3, but not including Simplot as a potential co-contributing source. That approach is employed in this analysis. Background concentrations for other criteria pollutants and averaging periods modeled were recommended by Mr. Schilling from the Pocatello area SIP analysis. Those values are shown below in Table 2.

EVALUATION OF COMPLIANCE WITH IMPACT STANDARDS

The impact limit standard applicable to this permit application are the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, and the IDAPA 58.01.01.585 and 586 limits for TAPs listed in Table 2. Predicted total concentrations reported is the model predicted maximum ambient impacts during facility operation plus background concentrations for criteria pollutants. Model predicted maximum impacts reported are the highest predicted impact for the annual average period and for all TAP analyses, and highest second maximum for all shorter averaging periods for criteria pollutants, consistent with the modeling protocol and IDEQ's comments. Table 2 shows the maximum model predicted impact each year for each pollutant for each averaging period modeled.

Table 2 reports predicted maximum model predicted impacts and associated worst-case ambient concentrations as a result of the proposed action. This table provides all model impact results required on the IDEQ MI forms. Predicted maximum impacts and ambient concentrations do not approach or exceed any applicable impact standard.

Table 2
Background Concentrations, Ambient Impact Limits and Method of Comparison with Ambient Air Quality Standards

Pollutant	Averaging Period	Background Concentration (μg/m³)	Modeled Maximum Impact (μg/m³)	Total Concentration (μg/m³)	IDEQ AAC or AACC (μg/m³)	NAAQS (μg/m³)	Total Conc. as % of applicable Impact limit
PM_{10}	24-hour	94.6	45.3	139.9	-	150	93.3%
	Annual	25	9.6	34.6	-	50	69.2%
NO_2	Annual	32	8.2	40.2	-	100	40.2%
SO_2	3-hour	34	86.3	120.3	-	1300	9.3%
	24-hour	26	24.9	50.9	-	365	14.0%
	Annual	8	0.5	8.5	-	80	10.6%
CO	1-hour	5000	464	5464	-	40000	13.7%
	8-hour	2000	136	2136	-	10000	21.4%
HCl	24-hour	-	267	-	375		71.2%
Arsenic	Annual	-	0.00001	-	2.3E-04		6.2%
Benzene	Annual	-	0.00024	-	0.12		0.2%
Benzo-a-pyrene	Annual	-	<0.00001	-	3.0E-04		small
Cadmium	Annual	-	0.00008	-	5.6E-04		17.9%
Formaldehyde	Annual	-	0.00452	-	0.077		8.7%
Nickel	Annual	-	0.00015	-	4.2E-03		35.7%
PAHs	Annual	-	<0.00001	-	0.014		small

The maximum model predicted impacts for arsenic and nickel, the two TAPs modeled as normalized "NGTAPs" with an emission rate of 1 ton per year, were calculated as follows from the model results of a maximum annual average impact of 0.15619 g/m³:

Arsenic: (Actaul emission rate of 9.18E-05 tons/yr)(0.15619 ug/m^3/ton per year of emissions) = 1.43E-05 ug/m^3
Nickel: (Actaul emission rate of 9.64E-04 tons/yr)(0.15619 ug/m^3/ton per year of emissions) = 1.51E-04 ug/m^3

Maximum model predicted impacts for each pollutant and averaging period occurred at or within 10 meters of the ambient air boundary. The maximum impacts are shown to be well below all applicable impact limits for all TAPs. None of the predicted maximum TAP impacts reached half the applicable standard. Total concentrations under worst-case operating conditions would not reach half the NAAQS for any pollutant other than PM-10. The PM-10 impacts and maximum ambient concentrations are shown to be well below applicable impact limits for the annual average period. The primary reason that total PM-10 concentrations are predicted to exceed half the NAAQS is because the IDEQ recommended background concentrations themselves are at least half the NAAQS. Maximum predicted facility impacts are shown to be low enough to prevent any exceedances of that NAAQS under worst case operating conditions, though.

Figure 5 shows the maximum model predicted 24-hour average facility PM-10 impacts. Color coding shows the maximum facility impacts occurring on the western property boundary in the vicinity of the lab building near the southwest property boundary. Impacts are predicted to be considerably lower along the rest of the property boundary, except where Great Western emissions elevate impacts on the east end of the facility. All receptors with predicted second maximum 24-hour average impacts over 10 ug/m^3 are shown in bold. As with all other pollutants, predicted impacts drop off promptly and continuously away from the ambient air boundary. All significant impacts for PM-10 are bounded within the model receptor network.

Figure 5 Model Predicted Maximum 24-hour Average PM-10 Impacts